Application and verification of ECMWF products 2016

RHMS of Serbia

1 Summary of major highlights

ECMWF forecast products became the backbone in operational work during last several years. Starting from ten days deterministic forecast, amount of products in use is growing constantly including EPS, EFI, seasonal forecast etc. Available ECMWF software like MetView and GRIB_API are widely used.

Establishing of South East European Climate Change Centre started during 2008. In order to provide numerical background for monthly forecast for the region, regional Eta model runs with 6 months EPS forecast as boundary conditions, every month. Also, WRF-NMM and NMMB use ERA fields for case studies and numerical tests for different regions.

Since this year regional NMMB model is running preoperational on Cray supercomputer. Scheduling scripts for NMMB running on Cray were created in EcFlow this year and procedure for time critical application is started in order to use products in operational weather forecast.

New products available in our service are vertical cross sections of several products and model simulated METEOSAT SEVIRI 10 Brightness Temperature (Channels 5 and 9) together with derived Positive vorticity advection (PVA) at 300 and 500 hPa and Temperature advection (TA) at 700 and 850 hPa (Section 2.2).

2 Use and application of products

ECMWF products are used for short-range forecast for providing meteorological background for hail suppression activities.

Medium range forecast is mainly based on ECMWF products from deterministic model as well as EPS products.

Hydrometeorological Service of Serbia regularly issues monthly forecast for several places in Serbia. Statistical method by analogy is used together with EPS products from ECMWF.

RHMS of Serbia has continued to use ECMWF's monthly forecasts as well as seasonal forecasts.

2.1 Post-processing of model output

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

ECMWF's boundary conditions are used for WRF-NMM, a Non-hydrostatic Mesoscale Model, horizontal resolution about 10km since 2007 and horizontal resolution about 4 km since 2009. Also, NMMB, a Nonhydrostatic Multiscale Model on the B-grid, horizontal resolution about 4 km, is using IFS and running on Centre's supercomputer since this year. Some verification results compared to ECMWF forecast are presented in chapter 3.1.2.

2.1.3 Derived fields

2.2 Use of products

Some of ECMWF forecast products, like CAPE and EFI are widely used in every day work. Wind gusts, 2m minimum and maximum daily temperature forecast as well as daily amount of precipitation are used as a background in the severe weather warnings.

Prediction of the heat waves started operationally in August 2008. Maximum temperature predicted in deterministic model run and distributed as BUFR weather parameters is used as a first guess. During winter minimum temperature is used for prediction of the cold waves.

New products in operational use:

- **Horizontal fields**
  Cloud brightness temperature - ch5 i ch9 (CLBT)
  Precipitation type (PTYPE)
  Visibility (VIS)
  10 metre U-velocity (10U)
  10 metre V-velocity (10V)
  Snowfall index (SFI) - accumulation (EFI and SOT)
  Positive vorticity advection (PVA) 300, 500 hPa (derived field)
  Temperature advection (TA) 700, 850 hPa (derived field)

- **Vertical cross sections:**
  Divergence (D)
  Potential Vorticity (PV)
  Wind (from U and V) - (derived field)
  Vertical velocity (W)
  Relative humidity (R)
  Equivalent potential temperature (derived field)
  Positive vorticity advection (PVA) - (derived field)
  Temperature advection (TA) - (derived field)

3 Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

The 00 UTC run of ECMWF deterministic forecast is verified against SYNOP observations. Forecast data were taken from 0.125° x 0.125° grid, using grid points closest to chosen synoptic stations. Statistical scores presented here are related to station Beograd - Karađorđev park (13274).

MAE and RMSE of 2m minimum (18-06 UTC) temperature forecast (Fig. 1) do not differ significantly compared to the previous year during the whole forecast range except day D+7 when they are a bit larger (0.4°C). These scores for maximum (06-18 UTC) temperature forecast (Fig. 2) are larger than 2014 (from 0.1°C for D+0 to D+3 to 0.6°C for D+9).

Scatterplots (Fig. 3-4) show that there is still an underestimation for midnight (72h) 2 meter temperature. The "percent correct" of the 2 meter temperature forecasts within ±2°C is 75% for midday (60h) and 58% for midnight (72h) forecast.

A slightly overestimation of 10 meter wind forecast can be seen in Fig. 5 and 6, for wind speed lower than 4 m/s and slightly underestimation for wind speed higher than 5 m/s. The "percent correct" of the 10 meter wind speed forecasts within ±2 m/s is 92% for midday (60h) and 90% for midnight (72h) forecast.

Figures 7 and 8 show scores for 2 meter temperature and 10 meter wind speed forecast. Diurnal cycles in forecast errors can be seen, stronger for 2 meter temperature forecast. For 2 meter temperature forecast there are local minima of MAE and RMSE at 6 UTC and local maxima at 18 UTC during almost the whole range. MAE and RMSE of 2 meter temperature are mostly a bit larger (0.2°C to 0.4°C) than 2014 from 96 to 240 hour. All scores for 10 meter wind speed forecast are similar as last year.

Amounts of precipitation smaller than 5mm are overestimated and larger than 10mm are underestimated for both 54h and 78h precipitation forecast (Fig 9-10).

3.1.2 ECMWF model output compared to other NWP models

ECMWF model output is compared with several regional NWP models operational in HMS of Serbia.

Verification of operational regional numerical weather prediction models started in 2007. As new regional models were included in operational run, verification of their products followed. Models are ETA, WRF-NMM, NMMB with different initial and boundary conditions (IFS, GME/ICON, GFS). Meteorological variables verified every six hours are mean sea level pressure, temperature at 2m and wind speed at 10m. 24 hour precipitation amount and occurrence with different precipitation thresholds are verified too. Only the 00 UTC run is considered, up to 48 hours of forecast.

For model intercomparison, verification is done over the largest common domain of the participating models (47.38/10.65/40.37/25.25). 39 synoptic stations are chosen, 33 land and 6 mountain stations. Half of them are in Serbia. Observations are from BUFR data and the nearest grid point to the station is used. Height adjustment is not used.

Numerical weather prediction models operational in HMS of Serbia:

ETA ETA with BC from ICON DWD. Horizontal resolution is about 26km (0.25° x 0.25°).

ECNMM10 WRF-NMM v3.0 with BC from IFS ECMWF. Horizontal resolution is about 10km (0.125° x 0.125°).

ECNMM4 WRF-NMM v3.5.1 with BC from IFS ECMWF. Horizontal resolution is about 4km (0.05° x 0.05°).

DWDNMM WRF-NMM v3.1.1 with BC from ICON DWD. Horizontal resolution is about 12km (0.125° x 0.12°).

GFSNMM WRF-NMM v3.2.1 with BC from GFS NCEP. Horizontal resolution is about 12km (0.125° x 0.125°).

NMMB12 NMMB with IC and BC from NMMB global model (with IC from GFS NCEP) Horizontal resolution is about 12km (0.126° x 0.108°).

NMMB4 NMMB nested in NMMB12. Horizontal resolution is about 4km (0.042° x 0.036°).

ECMWF IFS model of ECMWF. Horizontal resolution is about 16km (0.125° x 0.125°).

Comparison of the forecast quality of ECMWF model and our operational NWP models is presented in figs. 11-18. Seasonal averaged values for mean sea level pressure, 2 meter temperature and 10 meter wind speed 36h (midday) forecast and 24 hour precipitation occurrence are taken in consideration.

Values of ME and MAE for mean sea level pressure forecast of ECNMM4 and ECNMM10 are comparable with these values for ECMWF (Fig. 11-12).

ME of ECMWF forecast for 2 metre temperature has the smallest amplitude among all other NWP models (Fig. 13). Values of MAE show advantage of ECMWF forecast for 2 metre temperature during winters, while ECNMM4 2 meter temperature forecast have better scores during other seasons. Also, values of MAE score for NMMB4 model are comparable to values of MAE score of ECMWF and ECNMM4 since JJA15 (Fig. 14).

ECMWF has best scores for 10 meter wind speed forecast compared to other models' scores during all seasons (Fig. 15-16).

As for the ME of forecast for 2 metre temperature, values of ECMWF's FBI have the smallest amplitude among all other NWP models (Fig. 17).

Regarding ETS, evaluation of precipitation forecast is similar for all the models mostly with minimum skill in summer and maximum in winter. ECMWF's ETS score is a bit better than the other models' ETS score (Fig. 18).

3.1.3 3.1.3 Post-processed products

3.1.4 3.1.4 End products delivered to users

3.2 3.2 Subjective verification

3.2.1 3.2.1 Subjective scores (including evaluation of confidence indices when available)

3.2.2 3.2.2 Synoptic studies

4 References to relevant publications

Nurmi, P., 2003: Recommendations on the verification of local weather forecasts, *ECMWF Technical Memorandum No. 430*

http://www.ecmwf.int/en/forecasts/quality-our-forecasts

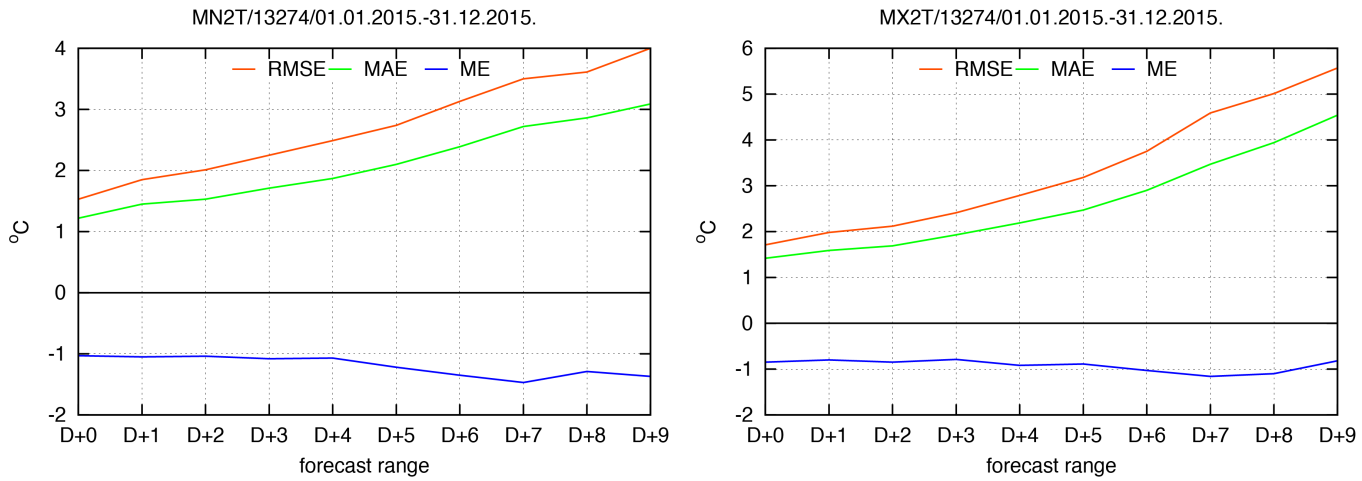

Fig.1-2 ME, MAE and RMSE of ECMWF 2 meter minimum and maximum temperature forecast (D+0 to D+9) as a function of forecast range (Beograd - Karađorđev park).

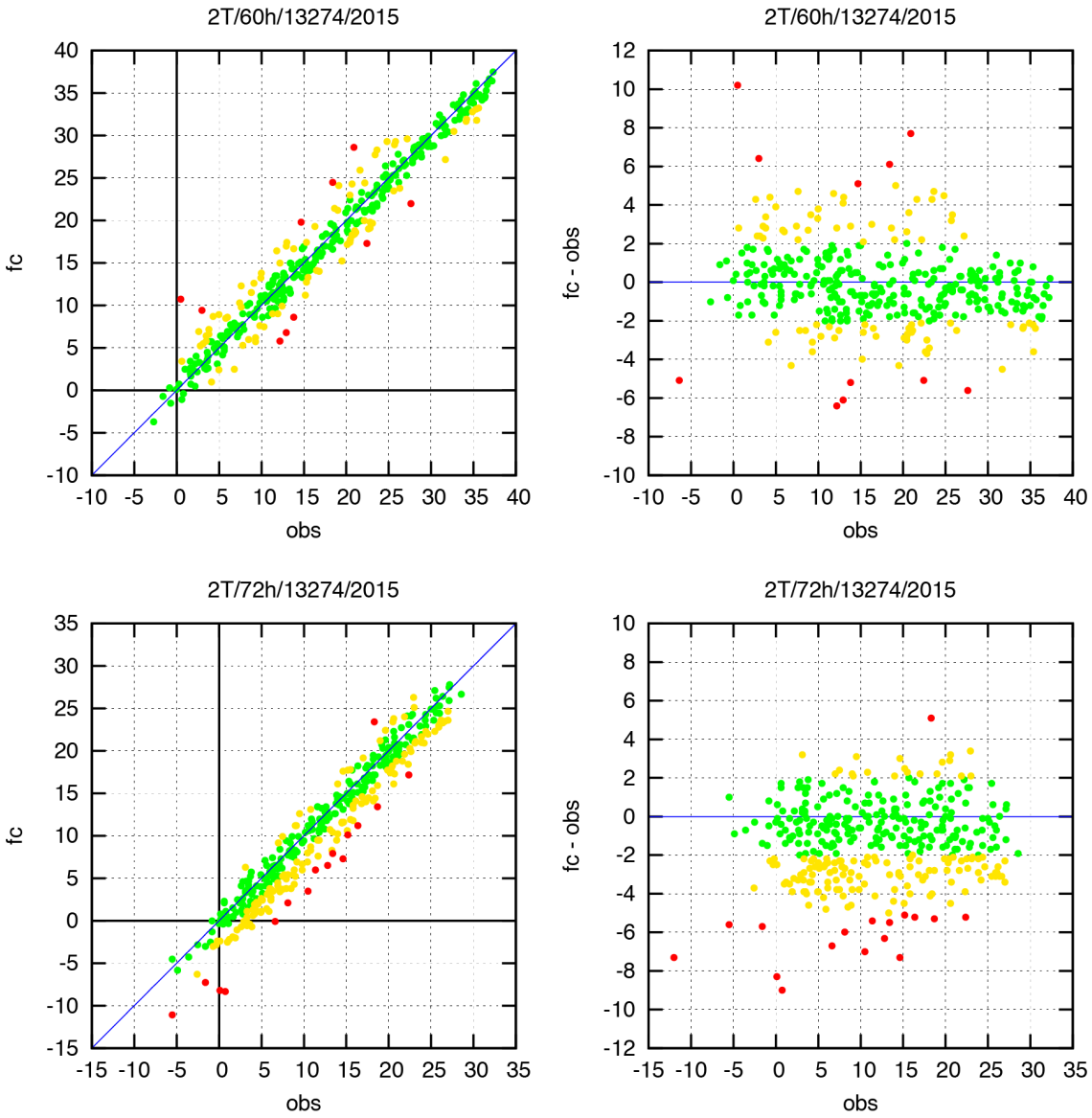

Fig.3-4 Scatterplots and forecast errors vs. observations of one year ECMWF t+60h (midday) and t+72h (midnight) 2 meter temperature forecast for Beograd - Kara?or?ev park (13274).

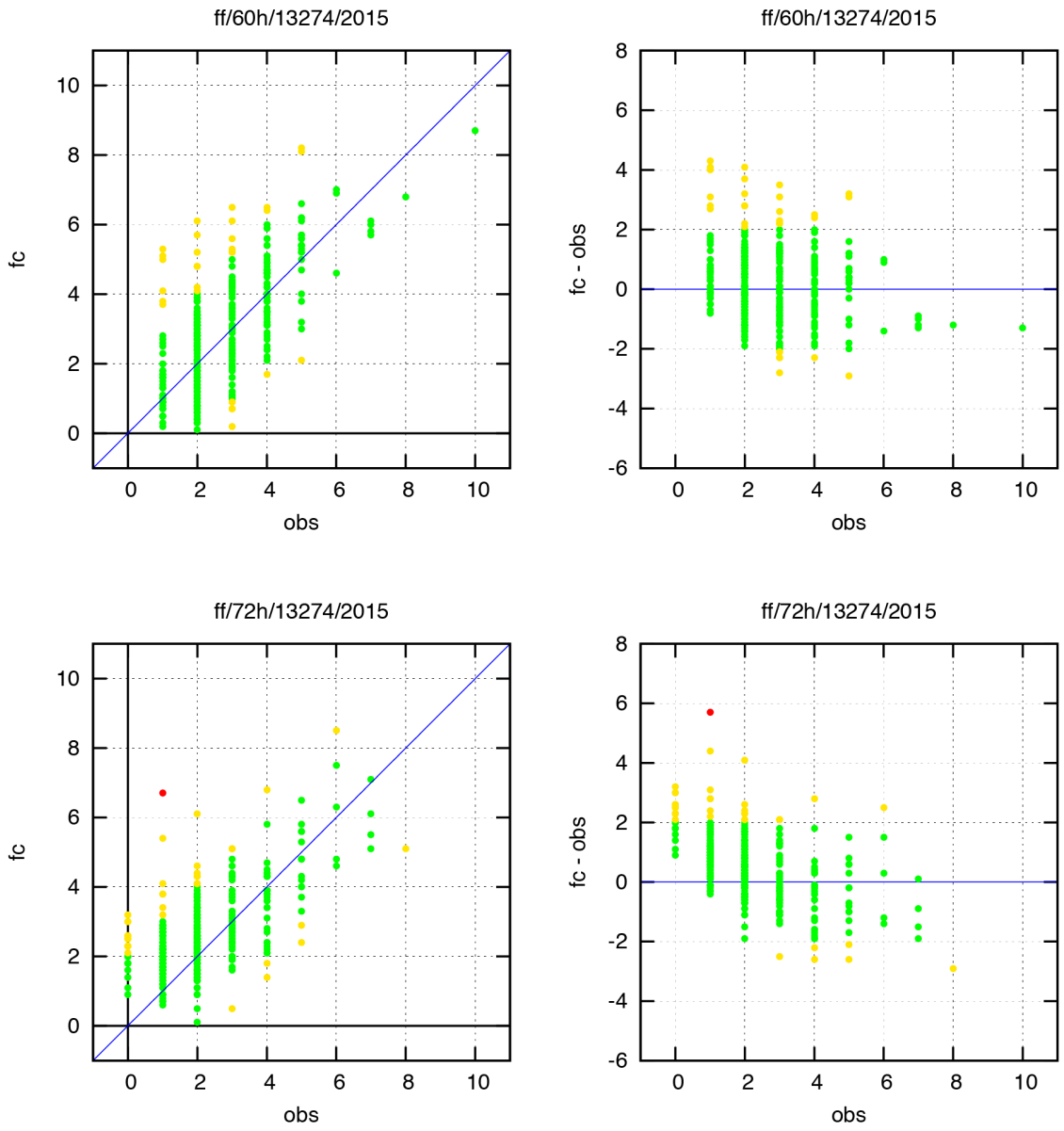

Fig.5-6 Scatterplots and forecast errors vs. observations of one year ECMWF t+60h (midday) and t+72h (midnight) 10 meter wind speed forecast for Beograd - Karađorđev park (13274).

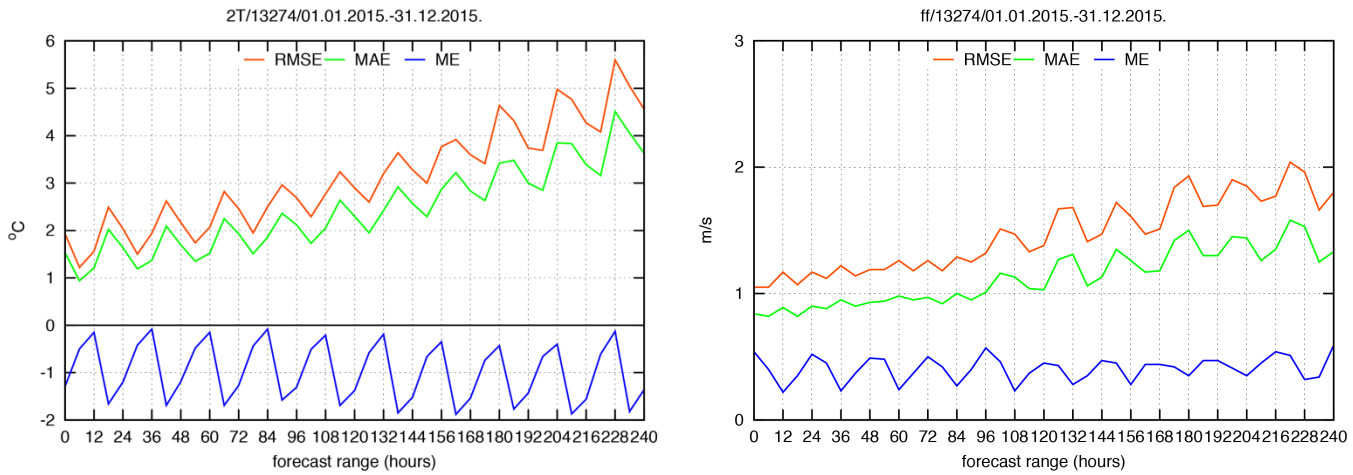

Fig.7-8 ME, MAE and RMSE of ECMWF 2 meter temperature and 10 meter wind speed forecast as a function of forecast range (Beograd - Karađorđev park).

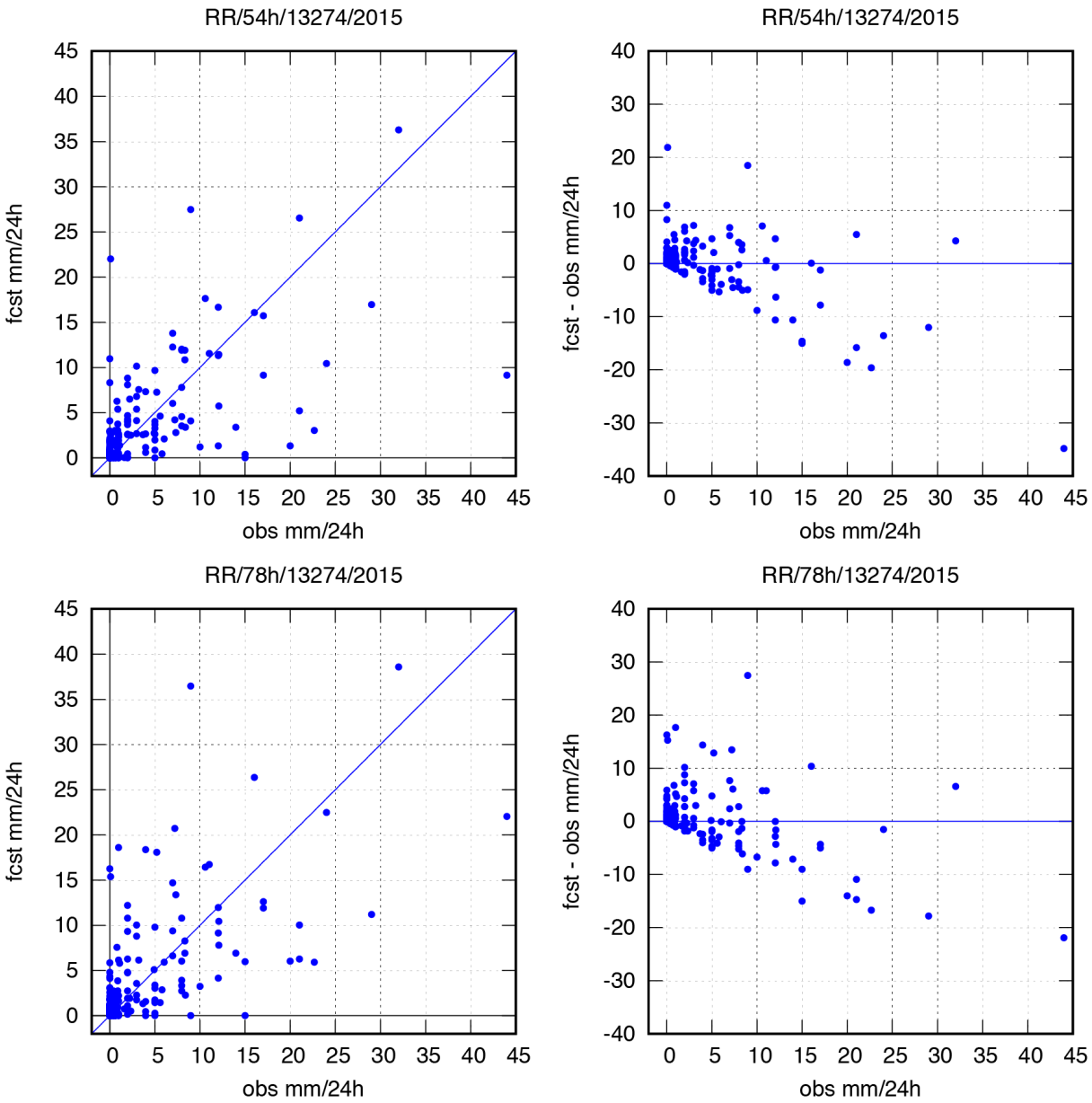

Fig.9-10 Scatterplots and forecast errors vs. observations of one year ECMWF 54h and 78h 24h precipitation forecast for Beograd - Karađorđev park (13274).

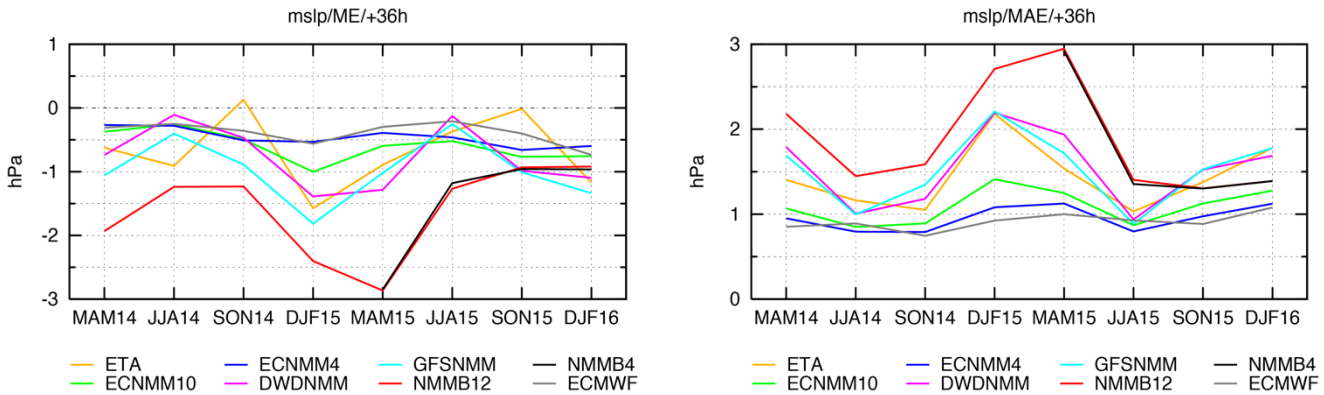

Fig.11-12 ME and MAE of ECMWF midday (36h) mean sea level pressure forecast for seasons MAM14 to DJF16. Comparison to operational NWP models forecast.

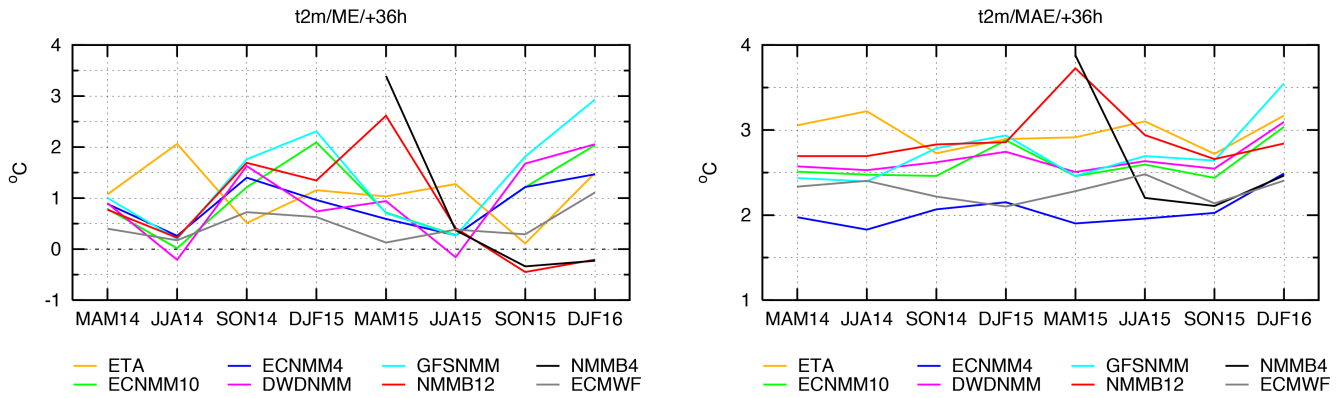

Fig.13-14 ME and MAE of ECMWF midday (36h) 2 meter temperature forecast for seasons MAM14 to DJF16. Comparison to operational NWP models forecast.

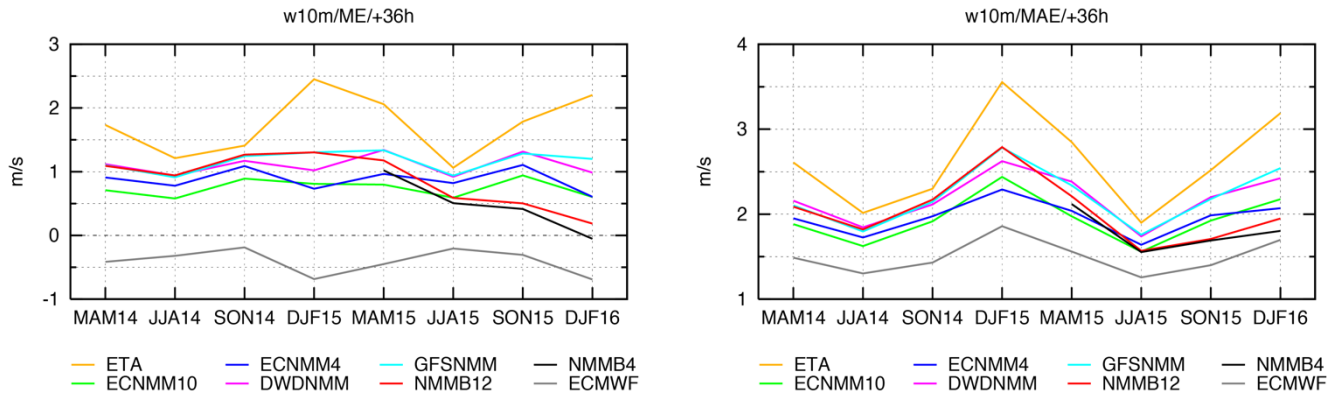

Fig.15-16 ME and MAE of ECMWF midday (36h) 10 meter wind speed forecast for seasons MAM14 to DJF16. Comparison to operational NWP models forecast.

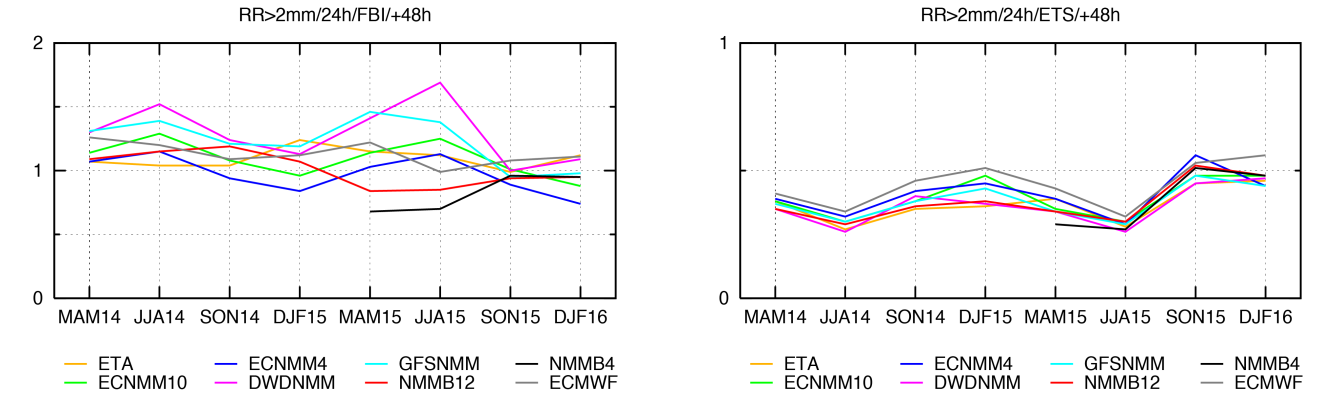

Fig.17-18 FBI and ETS of ECMWF 24h precipitation forecast (48h) for seasons MAM14 to DJF16. Threshold is 2mm/24h. Comparison to operational NWP models forecast.